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Sommario

PLENARY SESSION - INVITED SPEAKERS	5
GEOSITES	9
GEOLOGICAL HERITAGE AND LAND-USE PLANNING	90
GEOPARK AND GEOTURISM	130
COOPERATION AND EDUCATION	180
FIELDTRIP GUIDES	210

In copertina: Il promontorio di Capo Colonna Area calanchiva di Aliano

Quantitative assessment of geosites with national and international relevance in Portugal: methodological procedures

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ABSTRACT

During the last years geoscientists of various institutions have developed a project aiming the establishment of a geoconservation strategy in Portugal. One of the main goals of this project was the inventory of the most important Portuguese geosites with scientific value. The first step concerning this inventory was concluded with

the definition of the frameworks representing the most important geological features in Portugal and considering all geodiversity. With the participation of more than seventy geoscientists, twenty-seven geological frameworks were defined according to their scientific value at both national and international levels. The scientific value together with the vulnerability was numerically assessed in order to obtain a sorted list of all geosites. The Portuguese geosites inventory will be used in nature conservation policies

and land-use strategies in different levels of the country's administration.

1. GEOSITES INVENTORY

The first systematic inventory of the Portuguese geological heritage is the result of an academic collaboration between experts in different institutions (Pereira et al., 2012). Three hundred and twenty two geosites with international or national scientific relevance have been inventoried under the scope of the scientific research project "Identifi-

Geological framework		Main geological theme(s)	Geosites
#01	Neoproterozoic-Cambrian Metasediments in Central-Iberian Zone	Stratigraphy; Petrology	6
#02	Palaeozoic Marbles of the Ossa-Morena Zone	Petrology	7
#03	Ordovician of Central Iberian Zone	Stratigraphy; Palaeontology	12
#04	Paleozoic succession of the Barrancos region	Palaeontology; Stratigraphy	6
#05	Exotic Terranes of NE Portugal	Petrology; Tectonics	7
#06	Geotraverse of the Portuguese Variscan Fold Belt	Tectonics; Stratigraphy	10
#07	Geology and metallogenesis of Iberian Pyrite Belt	Mineralogy; Petrology	8
#08	Marine Carboniferous of the South Portuguese Zone	Stratigraphy; Petrology	3
#09	Continental Carboniferous	Stratigraphy; Petrology	3
#10	Pre-Mesozoic granitoids	Petrology	10
#11	The Iberian W-Sn Metallogenic Province	Mineralogy	4
#12	Gold mineralisation in Northern Portugal	Mineralogy	7
#13	Meso-Cenozoic tectonic evolution of the Western Iberian Margin	Tectonics; Stratigraphy	18
#14	Late Triassic SW Iberian rupture of the Pangea	Stratigraphy; Petrology	4
#15	Jurassic record in the Lusitanian Basin	Stratigraphy; Palaeontology	6
#16	Cretaceous rocks of the Lusitanian Basin	Stratigraphy	3
#17	Dinosaur footprints of western Iberia	Palaeontology	6
#18	Meso-Cenozoic of the Algarve	Stratigraphy	13
#19	Cenozoic basins of the Western Iberian Margin	Stratigraphy; Palaeontology	4
#20	Landforms and river network of the Portuguese Iberian Massif	Geomorphology	39
#21	Karst systems of Portugal	Geomorphology; Hydrogeology	38
#22	Active and fossil coastal cliffs	Geomorphology	6
#23	Low coasts	Geomorphology	6
#24	Neotectonics in mainland Portugal	Tectonics; Geomorphology	30
#25	Vestiges of Pleistocene glaciations	Geomorphology	16
#26	Volcanism of The Azores Archipelago	Volcanism; Geomorphology	30
#27	Volcanism of The Madeira Archipelago	Volcanism; Geomorphology	20
Total			322

Table 1 - Geological frameworks and number of geosites of the first systemic inventory of the Portuguese geological heritage.

cation, characterisation and conservation of geological heritage: a geoconservation strategy for Portugal", sponsored by the Portuguese Foundation for Science and Technology between 2007 and 2010 (PTDC/CTE-GEX/64966/2006). The inventory (one of the project's outputs) was coordinated by the University of Minho team with the participation of the universities of Algarve, Aveiro, Azores, Coimbra, Évora, Lisboa, Madeira, Nova de Lisboa, Porto, and Trás-os-Montes e Alto Douro. The inventory procedures were based on the ProGEO methodology: definition of geological frameworks followed by the identification of representative geosites with national and international relevance for each framework. Ge-

framework leader was responsible for the geosites assessment.

In what concerns the assessment of the scientific value all geosites were evaluated with scores from 0 to 4, in accordance with the parameters set for the 6 criteria (Table 2) which have different weights in the final formula. The geosite scientific value is expressed by an index that ranges from 0 to 100 according to:

$$A*30 + B*20 + C*10 + D*15 + E*10 + F*15 / 4$$

The vulnerability assessment considers the possible degradation of geological features with the use as a geosite. Geosites were assessed using values from 1 to 4 to score the

responsibility of the Institute of Nature Conservation and Forests (ICNF). This was already expected in the Portuguese legislation for nature conservation (DL 142/2008) and established in a protocol signed between the ICNF and the University of Minho.

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A. Representativeness	Score
Can be an example to illustrate processes and features related with the framework	1
Good example to illustrate processes and features related with the framework	2
The best example to illustrate processes and features related with the framework	3
B. Key-areas	
Used as a national reference in scientific terms	1
Used as a international reference in scientific terms	2
Stratotype recognised by IUGS or a key area for IMA	3
C. Published scientific data	
Referred in national publications (journals, abstract books, thesis, etc.)	1
Main theme in national publications or referred in international publications	2
Main theme in international publications	3
D. Integrity	
Deterioration prevents the perception of essential geological features	1
Deterioration exists but do not affect the perception of essential geological features	2
Well preserved and without deterioration	3
E. Geological diversity	
Two different geological interests with scientific value	1
Three different geological interests with scientific value	2
More than three different geological interests with scientific value	3
F. Rarity	
One of the few examples at national level	1
The only example at national level	2
The only or one of the few examples at international level	3

Table 2 - Criteria to assess the scientific value of geosites

osites representing twenty-seven frameworks were selected exclusively for their scientific value (Table 1). Each geological framework was coordinated by a geoscientist that was responsible for the scientific characterisation of the framework and to invite collaborators to identify representative geosites (Brilha et al., 2010).

2. QUANTITATIVE ASSESSMENT OF SCIENTIFIC VALUE AND VULNERABILITY

The scientific value of geosites and their vulnerability were numerically assessed. The main aim of this task was the identification of the most important and most vulnerable geosites in each geological framework in order to establish geoconservation priorities. This procedure was coordinated by the University of Minho team, which has developed the method and the assessment criteria. Each

parameters set for each of the 5 criteria (Table 3). Each criterion has also a different weight in the determination of the final score. The geosite vulnerability is expressed by an index that ranges from 100 to 400 according to:

$$A*35 + B*20 + C*20 + D*15 + E*10$$

Scores between 100 and 200 means geosites with low vulnerability, while scores between 300 and 400 are considered as geosites having high vulnerability.

CONCLUSION

More than seventy geoscientists took part in this numerical assessment that is now important raw data to support nature conservation initiatives regarding protection of geosites. Taking into account the scientific value and their vulnerability, the inventoried geosites are now being integrated in the natural heritage database (SIPNAT) under the

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